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ABSTRACT

The American educational system increasingly shapes individuals to fit a production-consumption system. Most educators believe that education should provide career training and the basis for economic advancement, rather than reflect on past events. The questions--who we are, why we are here, and where we are going--are seldom discussed in public education today. Continued technological development has resulted in global concerns, including accelerating industrialization, rapid population growth, widespread malnutrition, depletion of nonrenewable natural resources, and deteriorating environment. These concerns have created a new kind of awareness that technology and its impact are irreversible. Increasingly, there is the realization that if present trends continue, self-destruction from overpopulation and high energy consumption is assured. The implication is that increased liberal arts knowledge will directly enhance a society's capacity to make choices, decide goals, and produce desired changes. This acceptance of a new liberal arts perspective, in turn, would increase the potential of education as a creator of intelligent, capable beings. (Author/DB)

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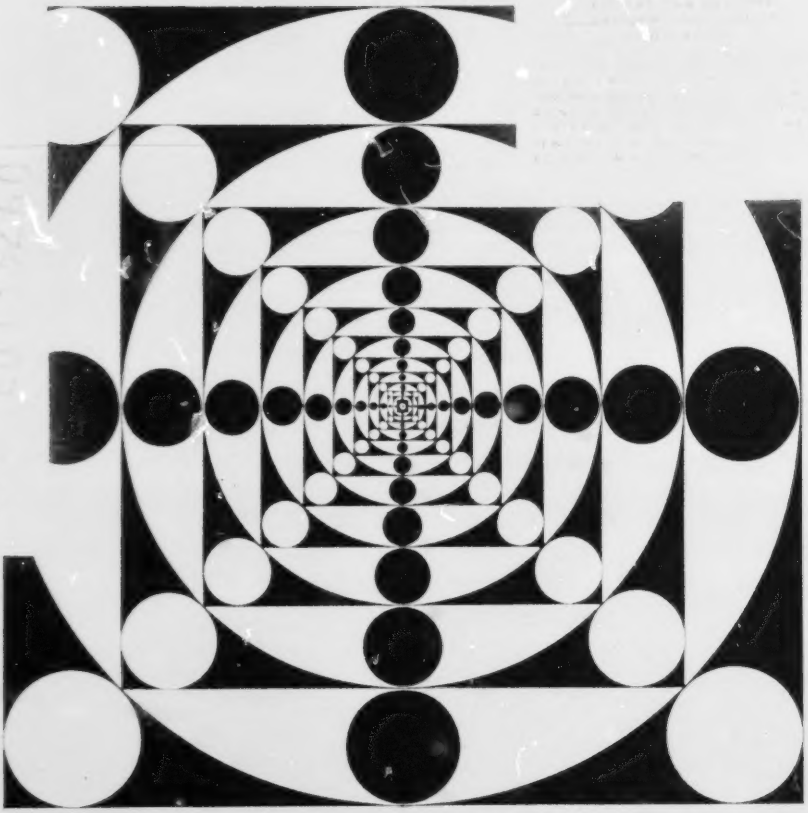

DEPARTMENT OF INDUSTRIAL TECHNOLOGY
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MONOGRAPH SERIES

1

TECHNOLOGY AND THE NEW LIBERAL ARTS

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TECHNOLOGY AND THE NEW LIBERAL ARTS

by

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One of the prevailing values associated with public education today is, "Education must pay off." And how should education pay off? The answer is: "In a job, in a career, in economic advancement." Are these not the most important goals for public education? Many believe they are. However, these goals may be the prelude to disaster. They may detract from the main mission of education in a democratic society. In fact, the present focus on careerizing and vocationalizing education and the acquiescence of educators to the philosophy underlying these two movements may be establishing the stage for vast political changes only now partially evident.

Today, in a society supposedly based on the premises of democracy and individual freedom and responsibility, the institution of education is concerned less and less with the process of education as a liberating force and more and more with education as a shaping and molding process. The focus has shifted from education and emancipation, to training and enslavement. The goal is to mold individuals to fit the system, a system based on economic rewards and a production-consumption mentality.

As a result, our future and the future of our children is being decided without reflection on, or contemplation about, factors which are more important than the short term issues of jobs, careers, and dollar return.

We are entering a new world, and we are not very well prepared for it. The basic questions of all time are still in need of answers. **Who are we? Why are we here? Where are we going?** There are questions that are seldom entertained in public education today; seldom raised in public forums. After all, we know the answers. Or do we? Notice the focus of the questions. The focus is on human beings. On individuals. They are questions that have to do with emancipation, with liberation, with freedom, with being human.

I submit to you that the answers to these questions have been and are being altered greatly by a little understood but very human endeavor, namely, technology; and that if we desire to liberate ourselves, the liberalization process must be concerned with the study of technology.

One of the tragedies of our time is the belated recognition of the importance of technology in the affairs of humankind. Technology has been and continues to be a powerful disruptive force in society. Throughout the history of humankind on this planet, technology has been the single most powerful change agent. The way we live, the way we think about ourselves and others, and our perception of the future are all affected by technology. Yet, with very few exceptions, educators maintain they are liberating students and providing a liberal education when the study of technology is ignored. We study sociology or anthropology or biology or psychology or theology, but not technology.

There has been established throughout history a false dualism that separates ends from means and contemplation from action.

This is a very curious position for educators to take. And one wonders why this is so. Certainly we are all aware of changes in technology. We are also aware of

changes in our society. Many of us are aware that there is a relationship between social change and changes in tools, techniques, and technical systems. Many of us can cite specific instances of new devices and new ways of doing things that are the result of a new technology. We know today that our choices and potential are totally different from those of our mothers and fathers. A brief review of recent literature in the field of technology identifies terms and phrases that describe the new technology and its implied and potential impact on the future. Terms and phrases* mentioned frequently include numerical control, interactive graphics, fluidics, wind power, space shuttles, geothermal energy, video discs, solar cells, negative feedback microwave ovens, and dial-a-ride, among others.

Each of these developments has already impacted either directly or indirectly on the question of education and what it means to be liberally educated.

What seems to be taking place is a belated recognition of the all pervasive force of technology in society. Educators have believed that to be liberally educated, students should study the literature and values of the past while those outside the field of education were creating new tools, new technics, and new technical systems which were altering the future. Because of this, the real impact of technology on education may be the questions that are being raised about the *raison d'etre* of the entire educational effort. And rightly so! Why? Because the educational system has for too long ignored the study of one of humankind's most creative endeavors. As a result, we are discovering the impact of the secondary and tertiary effects of technology. We are discovering that the spaceship earth is a delicately balanced entity of finite proportions. We are discovering that continued development of technology has brought about subtle, cumulative, and pervasive changes in both our natural and social environments. And it is these changes which are forcing the reconsideration of the mission of education at all levels. At issue are not the short range considerations of job or career education, but the far more serious and critical issues related to the stewardship of society and the spaceship earth.

During the last thirty years at least five major trends of global concern have

*Other terms and phases include: oceanic thermocline, collision avoidance systems, transponders, participatory technology, biomedicine, alternative communities, intermediate technology, coal gasification, breeder reactors, laser fusion reactor, L.E.D.'s (light emitting diodes), microwave communication channels, magnetohydrodynamics (MHO), Technology Assessment, fuel cells, linear induction motors, garnet lasers, containerization, technological forecasting, controlled environment greenhouses, ACT (air traffic control), long range satellite earth terrain cameras, Stirling powered external combustion engines, tidal power, hydrogen fuel, fuel injection, electronic ignition, climate stabilization, project Sanguine, ERTS,data networks, land use policy, computer-managed parts manufacture, SI metrics, Opaque-2 (corn), CPU's, LSI's (large scale integrated circuits), FET (Field effect transistor), MOS (metal oxide semiconductor), Supercritical wing, methanol, ozone, vinyl-chloride, technology utilization, technology transfer, genetic intervention, micro-computer, RAM (random access memory), ROM (Read only memory), DABS (Discrete Address Beacon System), CVCC (Compound Vortex Controlled Combustion), cable television, video tape cassettes, video magazines, industrialized housing, VTOL, STOL, V/STOL, biodegradation, and holography, among others.

developed as the result of continued technological development. (Meadows, *Limits of Growth*)

1. accelerating industrialization
2. rapid population growth
3. widespread malnutrition
4. depletion of non-renewable natural resources
5. deteriorating environment

These trends, all interrelated, have created a new and different kind of awareness about technology. The new awareness comes about because of the **magnitude of the impact** of changes in society and, secondly, because of a number of predictions of the **irreversibility of the trends.** (Watt, p. 56)

This new awareness has brought with it the realization that doing essentially more of what we have already done, only more so, will not enhance our humaneness or enable us to live a better life in the future. The last several decades have been filled with action, most of it based on minimal understanding of our complex technological and social systems, much to the detriment of humanity.

Our present system is operated largely from ignorance. We know little about the past with respect to technology and technological systems and their impact on society, and we know and care little about the future, inevitable as it is. Mostly we operate day-to-day in the eternal present, hoping that someone is concerned about our future. We operate on the faith that someone is steering the spaceship earth. Yet, there is a new awareness, an awareness that all is not right with the world.

We have become aware that our recent past has been focused primarily on an ever increasing material standard of living, a standard of living based on a **capital intensive** and **energy intensive** technology. We are beginning to wonder if we have developed a technology which has, within the system, built-in self-destruct elements. Many believe, if present trends of increasing production, consumption, and population continue, self-destruction is assured.

Two variables have been identified as factors in the self-destruct equation. They are:

1. **Growth.** This includes (a) an ever accelerating industrialization and
   (b) an exponentially expanding world population,
   and
2. **Energy Utilization.** With an ever accelerating industrialization there has been a proportional increase in energy use. The level of sophistication of technology is directly related to energy consumption. The higher the level of technological development in a given society, the higher the energy consumption per capita.

These two factors, couped with other factors, such as **individual resource ownership** and a **growth mentality**, have set the stage for a crisis of major

proportions, given the present direction of technological innovation.

Population growth, coupled with a higher standard of material living, brings about higher levels of environmental pollution, accelerating depletion of natural resources, and eventually, malnutrition resulting from decreasing food supplies. And shortages of resources and food fuel an ever increasing and continuing inflation.

The issues can be placed in sharper focus with some data and examples.

Growth

Until recently, economic growth was accepted as a positive value. The mentality was that more was better. Expanding population, utilizing an ever more powerful technology, exposed the danger of this mentality to industrial civilization. The critical variable was and is the expansive power of technology. And the critical question today is whether **an expanding population** (3.6 Billion in 1970 compared to a 1.0 billion population in 1798), coupled with **an acceleration of industrialism** throughout the world, can be sustained. The prediction is that there are limits; that the population (projected to reach 8.5 to 13.5 billion by 2050) will eventually outrun the potential and projected food supply and industrialization will be limited due to the limits of **natural resources** and **energy**.

There are, of course, those who posit that **demographic transition** will alter the equation and limit the growth of population. Demographic transition is the theory that birth rates decline as the material standard of people is raised. The theory is based on the experience of Western nations. The general pattern is as follows:

> Before development begins, the population is stable at a low level because both birth and death rates are high. In the developing period, the death rate falls dramatically, chiefly because of the impact of medical and public health measures, but the birth rate stays high. The result is a rapid growth in population. In the developed stage the birth rate falls to a point where it is again in balance with the death rate and the population is stable at a high level. (Gould #3, p. 6)

This theory of course raises questions. For instance, how high does the population go during the intermediate stage? Does the population reach a level capable of being sustained, in terms of food, energy, resources, and a standard of living comparable to the Western world today? The danger may be that a given population level, coupled with a given level of technology, will reach a critical mass. When a certain level of both population and technology is reached, deterioration of the quality of life sets in if economic growth is continued. Inflation increases. Costs per item soar. The ultimate limit, however, may not be numbers of people, or the availability of food supplies or resources. The ultimate limit to industrial activity may be determined by the amount of heat the ecosphere can absorb. (Wade, p. 598)

It is predicted that serious climatic problems will be encountered in the future with continued development of energy intensive industrialism. Robert Heilbroner notes that if the rate of increase in energy use was to continue at 4 percent per year, the atmosphere would begin to warm up appreciably, by some 3 degrees in 150 years, setting off all sorts of environmental catastrophies. If this trend occurs, the real need, then, will be to limit industrial growth before critical mass is reached.

Energy

The United States consumes more energy on both an absolute and per capita basis than any other country. In 1971, the total energy produced in the United States was on the order of 57,000 trillion Btu's. It is projected to rise to 92,000 trillion Btu's by 1985. (Commoner, p. 22) To meet these needs will require huge investments because energy production is **capital intensive**. This means that large sums of money are required to create energy production systems. If the present trend in energy utilization continues, together with present inefficient energy utilization processes, then it is predicted that energy production will consume an increasing amount of the capital available for investment in new enterprises, including factories, homes, schools, hospitals, and other public services. (Commoner, p. 27)

The energy equation is central to the question of the quality of life in the near and distant future. If the energy problem is not solved, all else fails; for modern technology, as we know it, is energy intensive. And the production and use of energy are at the base of the problems of growth associated with a deteriorating environment and the depletion of non-renewable resources.

The answer, perhaps the only answer, seems to be two fold. **One** possibility is to alter our life styles; to reduce the consumption of energy. **The other** possibility is to redesign our technology; to search for a technology that is less energy intensive and to search for new and alternative forms of energy which are non-polluting and not capital intensive.

The latter can be accomplished by turning to income fuels including solar, wind, water, and geothermal. Currently, these sources of energy contribute less than 4 percent to the total production of energy. Predictions are that in the future these sources and others will have to contribute 70 to 90 percent of our energy needs. (Cornish, p. 277)

The prognosis is not good, however. For instance, in 1974 the Energy Research and Development Agency (ERDA) selected **nuclear weapons production and development** as the highest priority in its budget. The next largest budgeted item was for the civilian nuclear program, including the breeder reactor. Coal research and development were targeted for only about 10 percent; conservation of energy programs, 3 percent; and income energy sources, such as geothermal and solar, about 1 percent. (Abelson, **Science**, July 28, 1974) This was truly an incredulous stance for ERDA and Congress to take at that time, given the seriousness of the

energy problem.

Most lay people believe that someone will find a way out of the problem; that someone will discover a new and magic machine or process.

The question is, "Will there be time?" — time to develop the new technologies; time to create new social mechanisms for social control. What is at issue is lead time. The creation of new and alternative technologies, as well as new and alternative social mechanisms, requires more and more time the more limited the resources and the more sophisticated the technology becomes.

The critical variable at this juncture seems to be social control. Our command over natural processes and forces far exceeds our techniques for social control, including planning and decision making. This is a relatively recent realization.

There seems to be an awakening to the need for social action. Recent research indicates a slackening of public approval for new technologies. There is more questioning. Technological progress is no longer accepted as good. There is a growing distrust in the way power holders manipulate the world; concern over maldistribution of resources; anxiety about the ethical implications of further technological advances in some areas of medicine and the biological sciences; and growing awareness that much scientific research lacks social relevance. (LaPorte, p. 121)

The public is becoming more and more aware of problems associated with the use and application of technology. Included is the growing realization that:

1. **Work** in a high technological society can kill. (HEW estimates that 100,000 U.S. workers die each year from occupational diseases.)
2. **Inappropriately applied technology** can destroy people and environments. Witness the inappropriately applied deep well technology in the Sahel. There was no social control and the nomads, carried away by the promise of unlimited water, forgot about the Sahel's limited forage. Centuries-old tribal agreements which apportioned just so many cattle to graze just so long in certain locales were ignored. Herds were increased, overgrazing resulted, and each well became the center of a desert of its own. (*Atlantic Monthly*, May 1974)
3. **The social costs** of the automobile are becoming excessive whether one considers the pollution factor, the energy problem, or the fact that 200,000 people were killed in automobiles in 1972, creating great losses and increasing capital investments in the form of hospitals and rehabilitation centers, among others.
4. **The products of technology**, designed from an economic rather than from a human or social point of view, have built in hidden social costs. Witness the planned obsolescence of the American automobile and the new American Ghettos created by the "Mobile

Home Revolution."

Searching for Answers

For years, we have accepted unplanned technological growth and development as inevitable. Invention and new development have been dependent largely on individuals, private entrepreneurship, and so-called luck. But this may change. Some people have discovered that technology can be influenced by human beings. And some people have gradually begun to realize that the principal limitations to developing new or alternative forms of technology are not technological constraints, but rather, our own human conceptualization of the way things can and should be.

We may be on the verge of a spiritual awakening with a new vision of human and social destiny and being.

Analysis of the past 200 years during the industrialization of the Western world indicates a certain spiritual emptiness with regard to humankind asserting control over the future. This point of view results when a few make choices for the many, a fact with considerable importance with respect to technology. Holloman (p. 10) notes that the technology employed in a given society depends markedly on that society's particular cultural and political framework; on its resources, values, and myths. This fact has been known for some time by those who have studied social and technological systems. Leslie White, in his work, *The Science of Culture*, 1949, discussed the same point and showed the interrelationship of society and technology.

> Every social system rests upon and is determined by a technological system but every technological system functions within a social system and is therefore conditioned by it. (p. 382)

This being true, the central problem of our time and the issue which should have a great impact on our concept of what it means to be liberally educated is the search for alternative technologies which meet the needs of human beings and enhance the quality of life in all its dimensions.

Technologies designed to enhance the quality of human life do not begin with new devices. These technologies begin with people and their education, organization, and discipline. It is for this reason that the new liberal arts should be dedicated to the study of technology, humankind's survival kit, together with the education of the human mind and spirit for the purpose of creating on this earth the most humane existence ever. The options are ours. And it is the human mind that will make the difference. Our challenge is to exercise our humaness. And we are human, according to René Dubos,

> to the extent that we are able and willing to make choices that enable us to transcend genetic and environmental determinism, and thus to participate in the continuous process of self-creation which seems to be the task and the reward of humandkind. (p. 80)

Two factors stand out in Dubos' description of being human. One concerns ability; the other, willingness to make choices. The first is of the **mind**. The second is of the **spirit**. Both are necessary components of the educated person of the future.

What does all this mean? Essentially, it means humankind has a choice. Doomsday is not inevitable. It is possible, even probable, but not inevitable. The golden age for humankind can come about, but only if we make radical changes in our behavior as stewards of the spaceship earth.

Who are we? Why are we here? Where are we going? These are the great questions that still call out to be answered. These are the questions the answers to which will provide us with direction for the future, an operating base, a philosophy. Trite? Perhaps so. But one only need recall the immediate and not too distant past to observe the results of a concern for power without a philosophy. On October 1, 1972, the **New York Times** published an editorial which points up the issue of philosophy, goals, and leadership. The lead paragraph sets the stage.

> **The Leadership Issue**
>
> The overriding consideration in this Presidential campaign is what may be called the leadership issue. As we noted Thursday in our editorial endorsement of Senator George McGovern for the Presidency, The Times believes that President Nixon has failed to lead the American people with any sense of moral purpose toward the broad social, economic and political goals of this American democracy. Despite some major accomplishments, this Administration has appeared to govern during most of the past four years not with any evidence of inner conviction and outward vision but rather with a mixture of opportunism, insensitivity and confusion of aim.

If we are to operate with clear vision, we must search for the proper goals for humankind, goals that are progressive and promote human values. We must search also for the **means to attain** these values once determined. In addition, we must find the **means to control and manage** the process once determined. Each of these steps will involve new and alternative forms of technology. The difference will be that we will have made a choice, a choice to direct and control the means, technology, to promote human values.

Again, there are implications for the new liberal arts. A society's capacity to make choices, to decide goals, and to produce desired changes is directly influenced by the general level of education of its citizens, particularly in basic knowledge in the sciences, the technologies, and the humanities.

A Question of Control

The system of technology we have today was not planned, was not directed, and is not controlled in the true sense of the term. Each segment of the system has been developed largely on its own and is quite independent of the total. The best

example of the independence of what should be a correlated interdependent system is transportation. Until recently, no one seemed to care about high energy expenditures and the built-in mechanisms which assured continuation of non-integrated competitive transportation modes. Witness the railroad, truck, barge, and air freight systems. Even the terminals are separated as to the management and correlation of the system; a system that should be inter-related.

Interrelatedness of Systems

Continued study of social and technological systems has identified the complex nature of the interrelatedness of the systems. Myrdal, in his work in developing countries, identified what he called a *circular causation* which, to him, implied that:

> if one condition changes, others will change in response, and that these secondary changes in turn will cause new changes all around. The conditions and their changes are thus interrelated and interdependent. (p. 3)

The discovery of systems and the interrelatedness of systems is new to the mind of man. In the past, decisions in all areas of life have been made as though they had no effect on other segments. Social decision making was not approached from a systems point of view, as is evident in Maurice Strong's discussion of decision making and past result.

> Clearly our past decisions have not been producing the results we expected. No one consciously decided to pollute our air or waters, to produce urban squalor that afflicts so many cities, to destroy so much of our natural environment of plant and animal life, and to produce the glaring disparities between rich and poor that characterize our global society. (p. 7)

Controlling the Process

Controlling overproduction, pollution, the depletion of natural resources, and the continued destruction of the ecosphere is primarily a social problem, not a technological problem. The search, therefore, must be not only for the means to increase the social awareness of human beings of their potential fate; the search must be for appropriate knowledge structures, belief systems, and social tools which will enable human beings to participate as a part of the total system without destroying it. Unfortunately, our understanding of technology and society and technological and social systems is at a very primitive state of development. The mental perspective of most individuals has been shaped over the years by a viewpoint of technology, society, and the economy which fosters aggressive attitudes toward the environment and the "triumph" of man over nature. There has been a total lack of ecological perspective. The central concept has been growth with the insistence that continued growth will solve all problems. (Burhans, p. 20)

The publication of *Limits of Growth* and other studies has altered our awareness about the problems associated with technology and deteriorating social and natural environments. Numerous forms of social resistance have developed as the result of

the new information. Information, then, in various forms, including publications such as *The Limits of Growth*, becomes a first level control device.

With the new information, a new form of control, focused at the community level, has been developing. Social resistance at the community level has resulted from the increased impact of industrial and governmental technology on health, land use, esthetics, and other aspects of the quality of life in the community. Organized citizen opposition has been occurring throughout the Western world. In the United States, government transportation and energy programs are persistently opposed by local communities. (Baram, p. 465) But not all efforts have worked as planned.

Some forms of control attempted by citizens have created effects the opposite of those intended. When individuals and families responded to appeals to reduce their energy consumption by reducing their demand for electricity, the power companies asked for rate increases to make up for lost revenues, a normal reaction by an industry whose prime goal is profit and a return on investment.

There are, however, other forms of control which offer more promise. They have been adapted from the realm of the physical technologies. They operate on the principle of negative or inverse feedback. The case of the citizen reducing energy useage and being charged higher rates is a case of **positive feedback**. The predicted behavior would be more reduction, followed by higher rates. **Inverse or negative feedback** may be more appropriate in the control of social systems, as proposed by Page.

Page tells the story of Thomas Edison and his first generating plant. Edison's first generating plant had two generators. When he turned the system on, one generator slowed down, the other speeded up. However, both generators were supposed to carry an equal load. They were identical generators, but one was slightly more efficient than the other. The system was designed with **positive feedback**. The more efficient generator was reacting to the extra set of windings which were connected so that, as the demand on the generator grew, its output voltage rose to compensate for higher transmission losses. This was positive feedback. The greater the load, the higher the voltage, which made the load appear still greater. The positive feedback in the design caused the more efficient generator to increase its voltage and output while the second generator dropped some of its load. Soon the first generator was overloaded and slowed down. The unloaded generator then speeded up and began to run away. Edison first tried to shift the load manually but finally resorted to heavy flywheels and gears. The system was operating with positive feedback and was **unstable**.

The solution was inverse or negative feedback. The extra windings on one generator should derive their power from the output of the other. The first generator would, when the load reached a certain level, signal the other to pick up more of its share. The system would then be perfectly balanced and stable. The system works just as well with 3, 4, or any number or generators. (Page, p. 46)

There are other systems where inverse feedback would balance the system. Transportation is one example. The transportation system today, government regulations excepted, operates on positive feedback. Presently, highway users pay taxes which become part of a highway trust fund which is used to build more highways for more cars. The result is less and less public mass transit because of fewer and fewer riders for the mass transit system and, therefore, less and less money to build and operate mass transit. The system is out of balance. Balance can be attained by using inverse feedback. Each part of the nation's transportation system receives its signal from another part just as the generator did. In terms of transportation, higher income from automobiles could be used to fund mass transit. As mass transit systems improved, their revenues could be used to improve air transportation, which could in turn contribute to rail transit systems, which could in turn contribute to the improvement of highway systems. (Page, p. 46)

Similar designs could be developed for equalizing educational opportunities and for developing various public services within a community.

Another system with some potential of aiding in the control of the social and technological systems has been proposed by Wagar (p. 1182). Wagar suggests that decisions be based on a **Quality of Life Index** rather than a **Standard of Living Index**. By using his system, there would be a continual evaluation of the effect decisions have had on one's quality of life. The **Standard of living index** is based on the theory that living improves as the per capita share of material goods increases either by increasing production or by decreasing losses or a combination of both. The formula is:

$$SL = \frac{\Sigma \text{ production} - \Sigma \text{ losses}}{\text{population}}$$

The **Quality of life index** places a value not only on material goods but also a value on the quality and quantity of both services and experiences available to each person. Thus, the environment becomes a factor in decision making. If the environment deteriorates, fewer opportunities are available for quality experiences or services are reduced. The formula is:

$$QL = \frac{\Sigma \text{ Production}}{\text{Population}} - \frac{\Sigma \text{ Losses}}{\text{Population}} + \frac{\Sigma \text{ Services/Time}}{\text{Population}} + \frac{\Sigma \text{ Experiences/Time}}{\text{Population}}$$

The Redesign of Technology

In the past, one dictum about technology was, "Whatever can be will be." This no longer need hold true. Some people have discovered they can, in some measure, determine what happens to their lives. They have found they can alter the course of technological development. Witness the SST, project Sanguine, and certain highway and marine terminal proposals. There is a danger, however, in stopping all technological development. Many technological developments have had positive

effects on enhancing humankind. While some technological developments have promoted impersonal efficiency-minded mass-production society, other technologies have been and are essential for a humane society. The problem seems to be three fold; (1) The type of technology that has been implemented, (2) The way the technology has been implemented, and (3) The amount of technology (growth). In many instances, technology has eliminated routine, repetitive jobs from the workplace. In other instances, the workplace has become more inhuman and destructive of individual qualities.

What needs to be remembered, as we examine the problems associated with creating a more humane world, is that new technological development can contribute to the solution of societal problems. In fact, as has been pointed out previously, technology can contribute solutions and aid mankind in making progress where non-technological attempts have failed. The use of computer models to simulate complex social and technological systems is one example. (Forrester) Negative feedback is another. (Page) Instruments designed to obtain information on the quality of the environment assist in decision making, as does the development of electrostatic precipitators and other technical solutions of air quality problems.

Deciding to correct a problem is one thing. Having people educated about technology and technological systems who can design solutions is another. Without the possibility of a solution, identifying the problem and deciding something should be done can be an operation in futility.

Examples of technological solutions to human problems which enhance the quality of human life include thermography, now used to detect breast tumors. Thermography is a heat picture. A thermograph of a tumor shows the extra heat generated by a growth in contrast to the surrounding tissue. (Collier, p. 132)

Another example is Opaque-2, a new corn with nearly double the effective protein content of normal corn, nearly as much as meat, and greater than milk. If the Opaque-2 gene can be transferred to the world's corn crop, it will be like adding ten million tons of protein to the world supply each year. This one development could eliminate the typical malnutrition which exists in societies whose basic protein supply comes from corn. (Friggens, p. 144)

Technology also contributes to new knowledge about our environment. Many of these developments came from the space exploration effort.

Earth orbiting satellites are one example of a technology that has had and will continue to have tremendous impact on the quality of life on earth. Again, a primary element in solving problems, namely, information, has been made available. The Earth Resources Technology Satellite (ERTS) and the Nimbus weather satellites are prime examples. ERTS shows great promise for data gathering for such activities as inventorying crops to determine the world food supply, planning efficient land use, prospecting for natural resources (oil, minerals, water), monitoring pollution, and preparing new maps for census taking.

Nimbus satellites have aided immeasurably in weather monitoring and predicting, saving many lives and increasing the probability of better harvests.

The goal of a humane society, meeting human needs and human purposes, can be attained once people are educated about the system and the complex interrelationships, and decide to alter technology and opt for a **free society** and a **directed technology**, rather than a free technology and a directed society. By doing so, humankind will be using human ingenuity not only to control technology but to redirect and reconstruct the technological and social system. The goal is a controlled and directed technology rather than an uncontrolled random technology. This will require citizens literate about technology.

Technological Literacy

To attain a reasonable level of literacy about Technology, consideration must be given to topics such as the following in the design of programs of study for today and tomorrow. A new knowledge base must be created incorporating the study of humankind; other cultures; social systems and the behavior of systems; decision making processes; change processes; the history and development of technology; goals and values in human societies; technological assessment; technological forecasting; the inter-relation of systems and the behavior and control of systems, both technical and social; new technologies and technological systems including power and energy systems, transportation systems, communication systems and production systems; alternative technologies; intermediate technologies; future social and technological systems; anticipatory technology; and the design of new technologies and new social and technical skills, among others.

New curricula for the public schools and colleges and new teacher education pre-service and in-service programs will be necessary. In addition, the design of new instructional strategies based on the most current research on communication processes, the learning process, and instructional technologies will be required.

To carry out these tasks a regeneration of the field of education is needed; a massive re-education of all practitioners, if any real contribution by the field of education to the education of youth for a future in a technological society is to take place. What is needed is new knowledge, new levels of awareness, new sensitiveness about humankind, about society, about technology and about the role of education in contributing to the education of individuals toward a more humane future.

This will require, for many, a reorientation of prevailing views of the purpose and function of education. The present emphasis on short term programs concentrating on jobs and careers will, on examination, be found to be destructive of the potential of education in creating a more humane society.

What if during the past thirty years the educational system had actually pursued the study of technology, rather than focused attention on diverse efforts such as

vocational programs, crafts programs, manipulative skill programs, occupations and the world of work programs, and antequated college preparatory or pre-vocational programs? **What if** during these years work had been carried on in the study of technology and technological systems and the interrelationship of systems? **What if** during these years focus had been on basic education in the technologies and the design and evaluation of technology for the home, the community, the social system? **What if** education had focused on the study of work, not from the standpoint of preparing for a job, but from the standpoint of work and its importance to humankind? **What if** education had focused on the design and redesign of technology to enhance work as a means of enhancing human beings? **What if** the practitioners in education had focused on the study of technology and the future and the span of civilization, rather than on the past and, to some extent, the contemporary present? Is it possible our citizens would have made other choices about the type and rate of development of technology? Is it possible that alternative forms of technology would have been developed; that systems of control would have been created that would have provided stability rather than instability?

If we believe in the potential of education as a creator of intelligent capable beings, **then** we would necessarily answer in the affirmative. Yes, today would have been different had the educational system included as a part of liberal education the study of one of humankind's most creative endeavors, technology.

But it did not. Instead, education and educators faced the future by looking backwards. They based the educational process on the past and conventional wisdom while supposedly preparing citizens for the future.

Is it too late for educators to take a stand and opt for a more stable and humane future? The record of educators as change agents has not been exceptional. Generally, the significant changes in educational institutions, in disciplines, and various fields of endeavor have usually been made by people outside the institutions or disciplines or by the young or by those new to the disciplines.

Thus, if we desire to make changes in education and to alter the future of society, we must solicit the assistance of those with a new perspective; those outside the institutions of education, the young, and those new to the disciplines. I propose we seek people such as these and dedicate this new facility to the new liberal arts and to those who will provide us, through study, reflection, and contemplation, with plans for purposeful action based on knowledge and understanding of the behavior of technological systems with the goal of directing technology for the creation of a more humane future for all people. Let us enter the future by choice, not chance.

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